OBSERVERSHIP REPORT

Manufacture of walnut hair serum — Streax, Baddi, Himachal Pradesh

Prepared by Harshdeep · Focus: the chemistry of formulation, emulsification and stability

I visited the Streax manufacturing unit at Baddi in Himachal Pradesh, which produces the Streax Walnut Hair Serum in 100 ml bottles. I was shown the route from raw-material dispensing to packed bottles, along with the quality-control laboratory. The line is highly automated, with PLC and SCADA controlled mixing, dosing and filling. This report focuses on the chemistry behind the product.

The chemistry of the serum

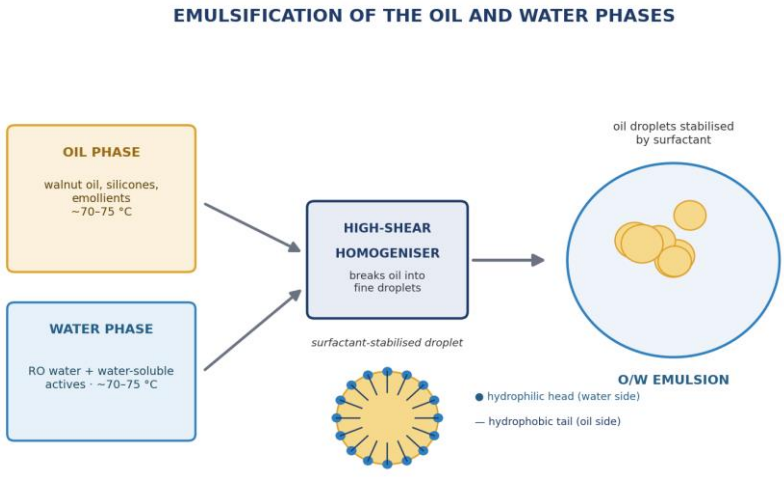
The serum is a leave-in hair-care product built mainly from walnut (Juglans regia) seed oil together with a set of silicones. It is not made by chemical synthesis; its manufacture is a physical process of blending and, where a water phase is present, emulsification. The formulation chemistry is really about choosing molecules for the feel, appearance, protection and stability of the product.

The silicones do most of the sensory work and share a silicon–oxygen (siloxane) backbone, with their differences coming from chain length and side groups. Cyclopentasiloxane and cyclomethicone are volatile carriers that spread the serum and then evaporate to leave a light, non-greasy finish. Dimethicone forms a smoothing film that adds shine and controls frizz, and phenyl trimethicone adds gloss and some heat protection. Isopropyl myristate is an ester emollient that improves absorption and reduces greasy feel, while tocopheryl acetate (vitamin E) and panthenol (provitamin B5) act as conditioning agents.

Walnut oil is rich in unsaturated fatty acids, whose carbon–carbon double bonds are prone to oxidation, which would turn the oil rancid. Vitamin E works as an antioxidant by donating a hydrogen atom to break the radical chain, so it protects the oil, and oxidation-sensitive actives are handled under a nitrogen blanket. The product is preserved with a paraben-free phenoxyethanol and ethylhexylglycerin system. Disodium EDTA is added as a chelating agent that binds trace metal ions, which would otherwise catalyse oxidation and spoil the formula, and citric acid adjusts the pH to a scalp-compatible 5.0 to 6.5.

Emulsification of the oil and water phases

Where the formula includes a water phase, the oil and water must be made to mix as an emulsion. Oil and water do not mix on their own, so a surfactant is used. A surfactant molecule has a hydrophilic head that sits in the water and a hydrophobic tail that sits in the oil. By coating the surface of each oil droplet it lowers the interfacial tension and stops the droplets from joining together, so a stable oil-in-water dispersion forms. In practice both phases are heated to about 70 to 75 degrees Celsius, combined, and passed through a high-shear homogeniser that breaks the oil into fine droplets. The mixture is then cooled to about 35 to 40 degrees Celsius before the heat-sensitive fragrance, vitamins and preservative are added, because higher temperatures would degrade them.



Emulsification: a surfactant coats each oil droplet, holding a stable oil-in-water dispersion.

The manufacturing process

The full sequence I observed is set out below. Ingredients are weighed by automated dispensers, the phases are heated and homogenised, the batch is cooled and the delicate actives are added, and after in-process checks and filtration the serum is filled, sealed, labelled and cartoned.



Flow of the walnut hair serum process observed during the visit.

Quality-control chemistry

The laboratory checks pH to keep the serum in the 5.0 to 6.5 range, and viscosity with a Brookfield viscometer because it controls how the serum pours and spreads. Density, appearance and odour are also assessed. Because the product can contain water, microbial testing for total viable count and pathogens guards against contamination. Gas chromatography is used to verify the fragrance and actives, and stability is predicted by accelerated ageing at 45 degrees Celsius and by freeze-thaw cycling.

What I learned

The serum showed me how modern cosmetic chemistry depends on formulation rather than on reactions: polymers and emollients are chosen for feel, a natural oil is protected from oxidation, and an emulsion is held stable by a surfactant. It let me connect classroom ideas such as intermolecular forces, oxidation and pH to a finished product, which strengthened my interest in chemistry.